IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Hampapur, et al.	Group Art Unit 2713
Appl. No.	:	08/870,836	
Filed	:	June 6, 1997	
For	:	KEY FRAME SELECTION	
Examiner	:	Anand Rao	

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July 14, 2000
(Date)

Raimond J. Salenieks, Reg. No. 37,924

AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

In response to the Office Action dated March 9, 2000 (Paper No. 12) in the above-referenced patent application, please make the following amendments:

IN THE CLAIMS:

Please amend Claims 1, 3, 4, 8, 11, 17, 18, 20 and 23:

1. (Thrice Amended) A computerized method of [extracting] identifying a key frame from a video, comprising:

a) providing a reference frame;

b) providing a current frame different from the reference frame;

c) determining a chromatic difference measure between the reference frame and the current frame;

d) determining a structure difference measure between the reference frame and the current frame based, at least in part, on edges identified in each of the frames; [and]

e) identifying the current frame as a key frame if the chromatic difference measure exceeds a chromatic threshold and the structure difference measure exceeds a structure threshold, otherwise selecting a new current frame; and

f) repeating c), d), and e) until a key frame is identified.

3. (Twice amended) The method defined in Claim [1] 2, additionally comprising repeating [c)-e)] b)-f) for a new current frame until another key frame is identified or the end of the video is reached.

4. (Amended) The method defined in Claim [3] 1, wherein the new current frame is selected to be at a predetermined time interval after the current frame.

8. (Thrice Amended) A computerized method of [extracting] identifying a key frame from a video having a plurality of frames, the method comprising:

a) providing a reference frame;

b) providing a current frame different from the reference frame;

c) determining a first difference measure between the reference frame and the current frame;

d) determining a second difference measure between the reference frame and the current frame based, at least in part, on edges identified in each of the frames; [and]

e) identifying the current frame as a key frame if the first difference measure exceeds a first threshold and the second difference measure exceeds a second threshold, otherwise selecting a new current frame; and

f) repeating c), d), and e) until a key frame is identified.

11. (Twice Amended) The method defined in Claim [8] 9, additionally comprising repeating [c)-e)] b)-f) for a new current frame until another key frame is identified or the end of the video is reached.

17. (Twice Amended) The method defined in Claim 8, additionally comprising determining a third difference measure between the reference frame and the current frame, and

wherein the identifying identifies the current frame as the key frame if the third difference measure exceeds a third threshold, otherwise selecting a new current frame.

18. (Thrice Amended) A computerized method of [extracting] identifying a key frame from a video having a plurality of frames, the method comprising:

a) providing a reference frame;

b) providing a current frame different from the reference frame;

c) determining a structure difference measure between the reference frame and the current frame based, at least in part, on edges identified in each of the frames; [and]

d) identifying the current frame as a key frame if the structure difference measure exceeds a structure threshold, otherwise selecting a new current frame;

e) repeating c) and d) until a key frame is identified.

20. (Twice Amended) The method defined in Claim [18] 19, additionally comprising repeating [c) and d)] b)-e) for a new current frame until another key frame is identified or the end of the video is reached.

23. (Amended) A computerized method of [extracting] identifying a key frame from a video having a sequence of frames, the method comprising:

a) providing a reference frame;

b) providing a current frame different from the reference frame;

c) determining a chromatic difference measure between the reference frame and the current frame;

d) determining a structure difference measure between the reference frame and the current frame; [and]

e) identifying the current frame as a key frame if the chromatic difference measure exceeds a chromatic threshold and the structure difference measure exceeds a structure threshold, [without accumulating differences between pairs of frames of the video sequence] otherwise selecting a new current frame; and

f) repeating c), d), and e) until a key frame is identified.

Please add new Claim 24 as follows:

24. A computerized method of identifying a key frame from a video, comprising:

a) providing a reference frame;

b) providing a current frame different from the reference frame;

c) determining a chromatic difference measure between the reference frame and the current frame;

d) determining if the chromatic difference measure exceeds a chromatic threshold;

e) identifying the current frame as a key frame candidate, otherwise selecting a new current frame and skipping f) and g);

f) determining a structure difference measure between the reference frame and the key frame candidate based, at least in part, on edges identified in each of the frames;

g) identifying the key frame candidate as a key frame if the structure difference measure exceeds a structure threshold, otherwise selecting a new current frame; and

h) repeating c) through g) until a key frame is identified.

REMARKS

Applicant adds new Claim 24 and amends Claims 1, 3, 4, 8, 11, 17, 18, 20 and 23 by this paper. Claims 2, 5-7, 9-10, 12-16, 19, and 21-22 remain unchanged and are also presented for examination. Reconsideration and allowance of all Claims 1-24 in light of the present remarks is respectfully requested.

Discussion of the Question Regarding a Journal Article

The Examiner asked why the article "Production Model Based Digital Video Segmentation" as it appears in the *Multimedia Tools and Applications*, 1995, by Arun Hampapur, Ramesh Jain and Terry Weymouth, as referenced in Zabih et al., U.S. Patent No. 5,767,922, was not disclosed in an Information Disclosure Statement. The article seems to be cumulative to Chapter 5 of the Hampapur Dissertation, University of Michigan, 1995, of which Jain and Weymouth were the co-chairs of the doctoral committee. However, Applicant's representative will be submitting the article in a Supplemental Information Disclosure Statement.

Discussion of the Claim Rejection under 35 U.S.C. § 102(e)

Claims 18-22 were rejected under 35 U.S.C. § 102(e) as being anticipated by Zabih et al. ("Zabih"), U.S. Patent No. 5,767,922. Zabih describes "detecting scene breaks in a sequence of video frames providing a moving picture. Entering and exiting edge pixels in each of a plurality of successive video frames are counted, and an edge change fraction for each of the successive video frames is derived therefrom. Peaks which are detected in the edge change fractions are indicative of scene breaks." The scene breaks include cuts, fades, dissolves and wipes.

Applicant's claimed invention is directed to a computerized method of extracting a key frame from a video having a plurality of frames. In contrast, Zabih identifies scene breaks which are typically five to ten or more frames in length. *See*, for example, the scene break peaks identified in Figure 7, each of which include multiple frames. Zabih does not describe how the system identifies a key frame - is it one of the frames from the scene break, is it the middle frame from a shot identified by a pair of successive scene breaks, is more than one frame selected from a shot, etc.

Applicant's claimed invention performs the key frame extraction by comparing a current frame to a reference frame. Some of the claims have been amended to clarify that a new current frame is selected if the structure difference measure does not exceed the structure threshold. Acts c) and d) are repeated until a key frame is identified. The reference frame stays fixed until the key frame is identified (Claim 19). In contrast, Zabih performs calculations on successive frames, as stated at Column 4, lines 49-52: "In order to detect scene breaks efficiently and accurately, in accordance with the present invention an edge change fraction is obtained in each of a plurality of successive video frames...". Applicant's claimed invention does not calculate an edge change fraction between successive frames, as performed by Zabih.

Since Zabih does not describe a computerized method of extracting a key frame from a video where the reference frame is fixed until a key frame is identified, Applicant submits that Zabih is overcome as a reference for Claim 18. Since Claims 19-22 are dependent on independent Claim 18, pursuant to 35 U.S.C. § 112, ¶4, they incorporate by reference all the limitations of the claim to which they refer. Therefore, the rejection of the dependent Claims 19-22 has also been overcome. Therefore, in view of the above, it is submitted that Claims 18-22 are clearly distinguished from the cited art and are patentable.

Discussion of the Claim Rejection under 35 U.S.C. § 103(a)

Claims 1-17 and 23 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Zabih, U.S. Patent No. 5,767,922, in view of the submitted Dissertation by Arun Hampapur, University of Michigan, 1995 ("Hampapur"). The Examiner cited pages 97-102 of the dissertation, and specifically page 97, lines 11-18.

Applicant's claimed invention performs the key frame extraction by comparing a current frame to a reference frame. Some of the claims have been amended to clarify that a new current frame is selected if the chromatic difference measure does not exceed the chromatic threshold and the structure difference measure does not exceed the structure threshold. Acts c) through e) are repeated until a key frame is identified. The reference frame stays fixed until the key frame is identified (Claims 2, 9). In contrast, Zabih performs calculations on successive frames, as stated at Column 4, lines 49-52. Applicant's claimed invention does not calculate an edge change fraction between successive frames, as performed by Zabih.

The Examiner stated that it would be obvious "to incorporate the Hampapur chromatic scaling teaching of the dissertation into the Zabih method in order to have dual measures, because no method works perfectly by itself (Zabih: column 16, lines 30-45)." The cited text is as follows:

> Our edge detection method does not handle rapid changes in overall scene brightness, or scenes which are very dark or very bright. Rapid changes in overall scene brightness can cause a false positive. Since a thresholded gradient-based edge detector is dependent on the relative contrast of regions in the image, large-scale scalings in image brightness will disturb the edge density of the scene. This effect sometimes occurs in scenes due to camera auto gain.
>
> Scene break detectors of the prior art based on intensity histogramming will also generate false positives when the overall scene brightness changes dramatically. Although the intensities change dramatically, the underlying edge structure of the image does not change. A more robust edge detection scheme may enable these events to be handled.

Applicant respectfully disagrees and submits that the cited passage teaches away from use of an intensity histogram and, instead, promotes a more robust edge detection scheme. Zabih does not describe how dual measures, dual thresholds and the sequence of applying the dual measures and the dual thresholds would be implemented.

Starting at column 12, line 60 through column 16, the Zabih reference tests its method of determining edge change fractions on sample video sequences against those of other methods (e.g.,

Nagasaka, Otsuji, Zhang, Hampapur). *See* the three sets of test results in conjunction with Figures 14-16, Figures 17-18, and Figures 19-20. Column 14, lines 34-38 describe an instance of a shortcoming of the Hampapur method, for example. The description of the contrasted test results is also used by the Examiner to reject dependent Claims 7 and 14-17. Regarding Claims 7 and 14, the Examiner stated that "the Zabih method, now incorporating the Hampapur chromatic scaling method as outlined in the dissertation, discloses that the second difference measure is only performed if the first difference measure exceeds the first threshold (Zabih: column 15, lines 1-20)". Applicant respectfully disagrees and submits that the cited text merely describes test results for two separate methods. Regarding Claims 15-16, the Examiner cited column 15, lines 30-68. Applicant respectfully disagrees and submits that the cited text describes test results for Zabih's method of determining edge change fractions without motion compensation and then with motion compensation enabled. The motion compensation is not a difference measure, but is done prior to computing the edge change fractions to digitally align successive frames. Regarding Claim 17, the text cited by the Examiner further describes motion compensation, which again is not a difference measure.

Note that the rejection of Claim 10 on page 6 of the Office Action dated March 9, 2000, appears to be in error. Claim 10 recites that the "first difference measure is orthogonal to the second difference measure", and is not similar to Claim 3.

Since Zabih does not describe a computerized method of extracting a key frame from a video where the reference frame is fixed until a key frame is identified, Applicant submits that Zabih is overcome as a reference for Claims 1, 8 and 23. Since Claims 2-7 and 9-17 are dependent on independent Claims 1 and 8, respectively, pursuant to 35 U.S.C. § 112, ¶4, they incorporate by reference all the limitations of the claim to which they refer. Therefore, the rejection of the dependent Claims 2-7 and 9-17 has also been overcome. Therefore, in view of the above, it is submitted that Claims 1-17 and 23 are clearly distinguished from the cited art and are patentable.

New Claim

New Claim 24 is supported by Figure 5 and the corresponding text at pages 9-11 of the patent specification.

Conclusion

By this amendment, Applicant has added a new claim and amended the claims. In view of the foregoing amendments and remarks, Applicant respectfully submits that Claims 1-24 of the above-identified application are in condition for allowance. However, if the Examiner finds any further impediment to allowing all claims that can be resolved by telephone, the Examiner is respectfully requested to call the undersigned.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: 7/14/2000

By:

Raimond J. Salenieks
Registration No. 37,924
Agent of Record
620 Newport Center Drive
Sixteenth Floor
Newport Beach, CA 92660
(619) 235-8550

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